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DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. I. NEW YORK, FEBRUARY, 1897. No. 12

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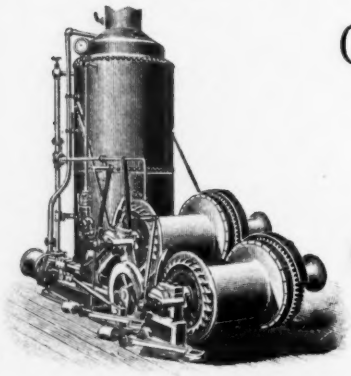

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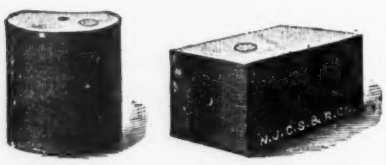

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Compressed Air

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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We referred briefly in our last issue to the important question of freezing in compressed air pipes and passages. Until recent years it was a common thing to criticise compressed air because of its freezing propensities, and it is well known that in the early use of the air brake freezing in exhaust passages gave trouble. We know of a case where an engineer designed a compound pump, using air at high pressure and expanding down through several stages. The result of this was that water was deposited within the cylinders to such an extent as to stop the pump. This was due of course to the reduction of temperature which brought the air below the dew point.

The amount of vapor in the atmosphere varies with each climate. Air in its natural state is never perfectly dry. This moisture is only mechanically mixed with the air and has nothing to do with its chemical composition. The capacity of air for holding moisture is affected by conditions of volume and temperature and not by density. In other words, a certain volume of free air will hold the same quantity of moisture as the same volume of compressed air. This may not be absolutely true, yet it is true for all practical purposes. Under average circumstances it has been found that there is about one pound of moisture or water in every 1000 cubic feet of free air. In compressing air to high pressures, say 2,000 pounds, this moisture is separated and is drawn off from the receiver, it being necessary, however, to first reduce the temperature of the air by passing it through an intercooler. It is therefore evident that it is easier to get dry air at 2,000 pounds than at 100 pounds, so that difficulties through freezing are not likely to occur in a properly designed high pressure installation.

In common direct acting pumps that use air at pressures below 100 pounds freezing in the exhaust may be easily prevented by letting a small stream of water into the exhaust passage. This stream need not be greater than the diameter of a needle, but it will serve very well to supply enough heat and to aid in a mechanical way to cut away frost and ice. As it is not difficult to find water where pumps are used this method of preventing freezing is a common one, but the true idea is to reheat the air before it is used. Strange to say this is uot done to any great extent because it is difficult to convince persons of the fact that reheating does something very much more important than preventing freezing, in that it adds to the economies of the system. We have recently had our attention called to a case in the West where reheaters are used even in the mines, some old shaft or other outlet serving to carry away the gases of combustion. In this case it has been found by experience that a little over one half a cord of good pine wood is

used every twenty-four hours to heat 700 cubic feet of free air per minute to a temperature of 350 degrees. The heated air in this case passes through pipes covered with magnesia and hair felt to the first cylinder of a compound hoisting engine from which it is exhausted back into another heater, its temperature having been lowered because of work done in the cylinder of the hoist. After bringing it back to 350 degrees the air is passed to a second cylinder where it is used at a pressure of about 30 lbs. It has been found that air after being reheated may be conveyed three or four hundred feet through covered pipes with but little loss in temperature, but it is always best to place the reheater as near the motor as the conditions of the case will admit.

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### Is Compressed Air Destined to Become the Rival of Electricity.

Many and marvelous are the inventions which have grown out of electrical discoveries and research, until it seems, from their multiplicity and present state of perfection, that the spirit of invention which animated these creations must soon slumber. Mighty, indeed, has been the revolution in the affairs of man wrought by electricity; under the command of genius, even though its march has been in the wake of that other potent force in civilization—steam. Notwithstanding these achievements, the commercial and industrial world is fast becoming conscious of the fact that its future rapid strides and ultimate commercial supremacy, as a motive power, will depend on cheapening the production of this form of energy, so as to oust steam, which feeds wastefully on costly coal. If this problem remains much longer unsolved, its toiling in the field of transportation, and in the workshop, will be shared by some other of nature's forces, for investors have begun to seriously realize that the millions which have been expended for franchises, dynamos, copper wire, etc., are not fruitful in dividends. It is stated that only one-fifth of the electric lighting stations in the United States are paying 4½%. Is it the uneconomical process of generating electricity by the initial power, steam, that is responsible for seventy-four electrical railroads, representing a billion and a half of dollars, being now in the hands of receivers? It is true that dynamos, in their present state of development, give out a high percentage of the engine's power imparted to them, and though we find the latter supplying in mechanical energy only 10% of that represented by the furnace heat, yet this wasteful process is not directly chargeable to the engine's incapacity to transform power delivered to it; but the trouble is due to the inability of the boiler to absorb and convert the major portion of the heat energy liberated in its fire-box. These significant facts have already influenced the recent course of electrical investments, and now the selection of a cheap initial power for generating electricity is the all-important question of the day. Eminent engineers and scientists are at work upon this problem, some endeavoring to produce electricity direct from coal or chemicals by rapid decomposition, or other methods of electro-chemistry, with a view of locating power plants in the coal-fields, or by the sea, and telegraphing the currents so derived to the cities for consumption, while others are seeking sources of energy to be found in water-powers, or in the fitful but giant forces of nature, as tides and winds—and the promise recently given that Niagara would soon be a captured Pegasus and harnessed, so as to become a useful wheel-horse, instead of a prancing, plunging steed, is now fulfilled.

This development of power in the bosom of nature, many miles distant from industrial centers, presents other problems, requiring skill of the highest order, in their solution, namely: the economical transmission and distribution of currents of

great magnitude and intense energy over long distances. When large accumulations of electric current are concentrated and prescribed to flow over a conducting wire, it becomes elusive and intractable as it flows forth, and rather than follow the pathway appointed for it to travel, it wastes itself, or passes to other substances and is dissipated so rapidly, that if it is transmitted any great distance the loss becomes so great as to render its transmission impracticable. Thus it can be seen that while electricity has not yet succeeded to its estate, the solution of these problems will mark a new era in the history of this subtle element. The applications of electric energy to industrial and commercial uses are so numerous and varied, and this singular phenomenon has received so much attention at the hands of the scientist, the engineer and the capitalist, that the world has become fascinated by its conquests, till now the impression prevails that electricity must necessarily become the motive power of the age. The writer does not claim that this, the above tendency, is a false one, but simply is set forth to show the reasons why other available forces in nature have received so little attention and consideration. Among these neglected forces, compressed air may be mentioned as a means of power transmission that has not received the attention it deserves.

### EARLY ATTEMPTS TO USE COMPRESSED AIR.

The application of compressed air to industrial purposes dates from the close of the last century, although before this we find isolated attempts were made to apply it in a variety of ways.

To the fertile brain of Dr. Papin, of France, we are indebted for the first suggestion of conveying parcels in a tube by compressed air, and he was the first to suggest the use of compressed air as a means of transmitting power. This distinguished Frenchman went to the expense of putting his ideas into wood and metal, but the results of his experiments were not encouraging. This was about A. D. 1700.

About a hundred years later, a Welsh engineer contrived an apparatus to utilize a water-power to work a blast furnace and machinery, a mile and a half distant, by compressed air, but the resulting blast was feeble.

For a century or more water elevators operating by compressed air have been used in the mines at Chemnitz in Hungary. Vague descriptions of apparatus for using compressed air in the mechanical arts are found in early English patents and publications, but none, so far as known, were practically applied. In 1810, Medhurst, of England, patented means for conveying parcels by compressed air. There is no authentic record that his project was reduced to practice, and it stands simply as a mile-post on the road toward the advancement of knowledge in this direction. In 1824, Vallance revived the idea of Medhurst. Contributions to this science were also made by such pioneers as Pinkus, Cleeg, and Pilbrow.

In 1837, the Italian government ordered experiments to establish the laws that govern air transmission, and improvements in methods and appliances have followed, resulting in the practical use of air for tunneling, in conveying parcels in tubes, and that valuable adjunct to railway trains—the air-brake.

Along about 1857 an American, Dr. Gorrie, exhibited in London and elsewhere cold-producing machines, in which air was compressed in one cylinder, cooled whilst compressed, and re-expanded in another cylinder, in a manner to utilize its expansive force. In 1859, a company was formed in London, and permanent pipes laid down for conveying parcels by air; these lines of pipe were extended in 1865. During the same year Ericsson operated eighty sewing-machines by compressed air in a factory in New York.

Experimental sections of pneumatic dispatch tube for carrying passengers were built at Sydenham, England, and in New York in 1867. The line at Sydenham was 600 yards long, and was traversed in fifty seconds with a pressure of 2½ ozs. per square inch. In 1872 Congress appropriated $15,000 for a pneumatic dispatch tube between the Capitol and the Government Printing Office in Washington.

Other systems have been multiplied by telegraph and express companies in Vienna and Berlin. The Western Union Telegraph Company conveys messages from lower Broadway to Twenty-third Street in New York, a distance of about three miles. They employ a vacuum, and the parcel travels between the terminals ordinarily in five minutes. Air was used for rock drilling in tunneling Mount Cenis, Hoosac, Arlburg, and other mountains, In 1879 air was used to propel cars on the Second Avenue Railroad, in New York.

This was briefly the state of the art up to 1880, but the dreams of Papin and the hopes of Medhurst were but partially realized. The disappointments of the past are, however, no cause for apprehension of final successful application of air for transmitting power. Many of the grandest successes of the present were absolute failures in the early attempts. Previous to 1880 the waste of energy in the compression of air, and the sickly design and faulty construction of mechanism for using air, due largely to the ignorance of the principles of thermodynamics, retarded the introduction of air as a mode of transmitting power. At Mount Cenis tunnel, the loss in compression was fully 90%. In the modern compressors the loss is less than 16%.

While compressed air has been used over and over again in a small way, and generally in a rough and uneconomical fashion, it was not until within a few years that any systematic attempt has been made to transmit and distribute this form of power for general consumption. To-day this is being successfully done in Paris and Birmingham, England, where the installations have given birth to applications and utilizations for purposes heretofore unthought of, with valuable economic results, and a realization of high efficiency in its workings.

In Paris the power is distributed not only to factories and electric lighting stations, but also finds domestic use, being sold to householders, restaurant keepers, etc., keeping them supplied with an available power which is turned to account in many useful ways, in producing the conveniences and comforts of life, while proving a welcome substitute for steam-power, with its heat, smoke, danger and waste.

The commercial advantages derived from these air systems have resulted in their rapid extension, and in Paris elaborate provision is being made to increase the size of the plant with a view of supplying an aggregate of 25,000 H. P.

### THE POWER YIELDED.

The general effiiciency of this mode of transmitting power in these two systems is conservatively put at from 80% to 85%, a showing that puts to flight the idea that the transmission of compressed air over a distance of several miles necessarily entails enormous losses. The attainment of this efficiency is gained by the help of another physical agent, in connection with the observance of certain simple laws, and an explanation in regard thereto may be readily understood without wading too deep into the water of science; and when understood will make clear the reasons why heretofore the progress in the introduction of a power so rich in possibilities has been impeded, while the truth becomes apparent that there is very little loss of power through its transmission if properly manipulated. In order that the reader may understand the elements involved in the solution of this problem it is necessary to gain a few preliminary ideas as to the behavior of

air under prescribed conditions. Air under compression when impelled to move in a certain path is governed by laws quite different from those affecting electricity. As the air flows through the pipes the resistance of the surface of the same has to be overcome, and whenever compressed air meets resistance the pressure falls slightly, but this moderate reduction in pressure does not involve a loss of transmission, because what the air loses in pressure it gains in volume, so that its mechanical effect may at any point be easily restored to initial capacity by the application of a small amount of heat, and it has been found that by this simple expedient its capacity to do work at the points of consumption many miles from the power-station is enhanced with but a nominal cost, and that no more economical effect of the application of heat has ever been found than this method of annihilating the effects due to friction in the air's transmission. An eminent English engineer declares that a quarter of a pound of coke per hour per indicated horse-power is sufficient to heat the air required in a moderate sized engine. Nor does this fairly illustrate its economic value, when we come to consider that it is capable of another important service (as alluded to in Dr. Gorrie's discovery) at the points of consumption, in the use of the by-product, the exhaust from the motors—for the purposes of ventilation and refrigeration. In Paris the restaurants and beer-cellers are supplied with refrigerant in this manner and which proves highly satisfactory in every respect and displaces the ice-melting method altogether, and in some cases is so sought after for cold storage that power is consumed essentially for its exhaust to use to this end.

In this country compressed air is being pressed into service in small ways in every branch of industry, but the use to which the public is most familiar is probably in its application to railway trains in its adaptation to applying the brakes; but its utility and operation in this connection are scarcely appreciated until we come to consider the conditions of its use. While we have all noticed that trains cannot be gotten under way until the locomotive has run some distance, to work up speed, it is doubtful if we have ever stopped to think of the tremendous momentum that is being piled up as that speed increases and the energy that must be destroyed in bringing a train to a sudden stop after it has gotten under way. It is estimated that the vast amount of energy that must be called into action at a moment's notice is greater than can be imparted to a projectile by the largest of modern guns. Its triumph in this direction is daily evidenced, and is the one important factor that has made speed in railway travel reconcilable with safety. How few of us have realized the importance of this daily performance. A train running 40 miles and hour traverses 59′ in each second—lurking danger appears in sight— the loss of one second through the lack of vigilence on the part of the engineer means its hastening on on errand of destruction by just 59′. By the touch of a lever the brakes are applied and the train that was rushing along at almost lightning speed is brought to a standstill in a minimum of time and within a distance of 400′ from where the danger was sighted, and this prodigious power that is brought to bear on the brakes is so ingeniously distributed and applied as to relieve the cars of all strain, while the train is promptly arrested in its flight without creating any commotion among the passengers or giving rise to a disagreeable shock.

JOSEPH W. BUELL IN *Inventive Age*.

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Several subscribers write for back numbers of COMPRESSED AIR.

To supply these friends of ours, we will pay twenty cents a copy for a limited number of the following issues. March, 1896, April, 1896, June, 1896, July, 1896.

### Fire Alarm Whistle.

Suburban towns that use fire alarms will be interested to know that the Compressed Air Whistle is the most effective means of proclaiming fire tidings that there is; and also that it is economical and automatic, and easy to install. Our correspondent, Capt. W. B. Sayre, says: "We have had a compressed air whistle in operation now about a year and find it a great success and eminently fitted for use in suburban villages, inasmuch as the cost is less than that of purchasing and mounting a heavy bell, and the alarm is a hundred times more effective for the simple reason that the ear becomes accustomed to the sound of a bell owing to adjacent church or school bells, and if a person living some distance from the engine house is sleeping soundly with windows closed and wind blowing outside, he probably will not be awakened, but the hidious screaming of our siren will almost wake the dead, as under ordinary circumstances, when the wind is not very high, it can be heard a distance of from five to eight miles distinctly, while it is doubtful if a two thousand pound bell would carry that far. Our plant consists of a boiler, an iron cylinder, eight feet long and forty-two inches in diameter, and capable of carrying one hundred and fifty pounds pressure. It is placed on the second floor of our engine house so as to be near the whistle and thus avoid unnecessary piping and probable leaks. It is fitted with pressure gauge and safety valve, as well as pet-cock at the bottom for drawing off water which condenses. Our whistle is an ordinary "Siren," such as is used on steam vessels and some few factories. It is 4½ inches in diameter, and the "chimer" is actuated by a drum and weight arrangement. This whistle is placed ten feet above the house so as to carry sound over adjacent buildings and is connected with the cylinder by inch piping; the chain which opens the valve in the whistle, trips at the same time the pall on the drum which operates the chimer and thus starts all off together. Our pressure is put on by a double action air compressor which is operated by an electric motor. These compressors can be had at most any price according to their capacity, from that capable of being run by main power—which would take, possibly a whole day to charge a tank the size of ours—down to the combination double action compressor, capable of putting 100 lbs. pressure on it in an hour but requiring five horse power to operate it. Our plant as it is, is a decided success. We carry 100 lbs. on our cylinder constantly and this will run our whistle about 90 seconds. It seems hours. When an alarm comes in, should it be at night, the driver as he slides down the pole from the sleeping quarters pulls the whistle chain and puts it on a hook and goes on about his business, and the whistle blows until exhausted or is released. It can also be used, after giving a long blast to awaken the firemen, to give the number of the box called by short blasts."

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Air power is employed to mechanically play an orchestrion in the Pembridge Square, London home of Mr. J. H. Van Ryn, well known in South African mining. Hitherto such instruments have had to be wound up. The maker, Mr. Makle, however, has patented the method of driving by a wind turbine. A current of air is generated by a hand compressor, a blower, or bellows, and passes through a pipe to the species of turbine which is similar to the well known cup anemometer. At Mr. Van Ryn's residence the air compressing apparatus for running the orchestrion is placed in a room under it and is driven by water pressure from the street mains.

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Compressed air locomotives for use in mines are classed as the most advanced method of hauling the product of the mine to the surface and to wherever it is wanted.

## Compressed Air vs. Electricity.

BY FREDK. S. WATKINS, M. E.

Closely allied to the generation of power, the transmission of power is a problem continually increasing in importance. Whatever the method used to convert the natural forces into useful work, the next problem is what system to employ to transmit this power to a distance, to be used as the circumstances of any particular case may require.

Although many different contrivances are in use for transmitting power within comparatively short distances, when we consider distances of say 1,000 feet or over, but two methods have yet attained any special prominence—electricity and compressed air. The rapidly awakening interest in the latter is but an indication of the future before it, when its general adaptability becomes better known.

In any problem of this class, in order to properly select from several different systems, we have the following points to consider :

1. First cost of complete plant.
2. Efficiency of system.
3. Cost of operation, including repairs.
4. Reliability, or freedom from breakdowns.
5. Difficulties met with in operation.

With the first cost we must also consider the efficiency or percentage of useful work realized, for as we are figuring upon a certain amount of power to be delivered at the end of the line, it is necessary to have a plant of sufficient size to deliver this amount of power, after allowing for all losses.

Any method requiring a number of separate stages, each with its own apparatus more or less complicated, must necessarily have large losses, requiring the expenditure of more work to obtain the final result, and this is one important point in which compressed air has an advantage.

Starting the same as an electric plant, with the prime mover, generally a steam engine, we find at once in the usual type of direct connected air compressor a machine so comparatively simple in construction, that good practice will show an efficiency in the compressor of 90 per cent. of the energy of the steam. The compressed air has then only to be condncted throngh a properly constructed pipe line to the point of application, in which practical tests have shown the loss to be less than 10 per cent. in distances of one mile.

In transmitting electricity to any distance the losses are heavy, requiring constant attention to the proper insulation and protection of the line, a slight accident to which would cause an enormous loss. Where compressed air can safely be relied upon for a loss of less than 10 per cent., electricity would ordinarily suffer a loss of not less than 30 per cent., frequently a much higher one. This shows that considerably less boiler and engine capacity is required by the compressed air plant, reducing first cost by no small amount. For transmitting the power, the pipe line required by an air plant may usually be taken at about the same as the cost of an electric line for the same power. Strange as it may at first seem to compare a pipe line to a copper wire in cost, when it is taken into account that the pipe requires no provisions beyond being tight, requiring no special protection against the elements, where the wire must be carefully insulated and strung on poles or placed in expensive underground conduits, all involving expensive outlays for labor and material, we at once see the cost more or less equalized.

Arrived at the point of application at the end of the line, the same simplicity always attends the compressed air operations, for we need but a properly designed engine built to perform its special duty, and ordinarily giving out in useful work 90 per cent. of the power received from the compressed air. We have in this instance about 72 per cent. of the power of our

prime mover transformed again into useful work one mile away. Even if the electric motor had the same 90 per cent. efficiency, it would give out at the end of the line but 57 per cent. of the power of the prime mover, at least 10 per cent. having been lost in the generator, and 30 per cent of this afterwards lost in the line. We have then 57 per cent. realized, as compared to 72 per cent. realized by the compressed air system, or in other words, the latter system would require that proportion less in boiler and engine capacity. This explains, in connection with the relatively lower cost of the machinery, why it is that a compressed air plant is so much lower in first cost than an electric plant delivering the same amount of power.

As for the cost of operation, since the compressed air plant requires less power to start with, it requires less fuel to supply the necessary power ; the amount invested being less, it represents less interest on the capital, and a smaller amount to be annually marked off for depreciation; the construction throughout being more simple and less liable to accidents, the item of repairs is very materially reduced.

Regarding the reliability, when we consider that compressed air is but little affected by atmospheric changes, and that all mechanism is readily accessible for repairs, we see that there is but little to get out of order, and only to be quickly and easily repaired. One greatly overrated cause of trouble has been the "freezing" or more properly "frosting" of the moisture contained in the air upon the expansion of the compressed air in the cylinder of the machine. This has been overcome in modern appliances, and when we hear of a compressed air machine freezing, we know it to be a case of carelessness or poor design, things that no process can always be free from.

The difficulties encountered in electrical operations are numerous, and in many cases impossible to overcome. Everything must be guarded with the closest scrutiny, demanding the highest skilled and educated labor; lightning, moisture, etc., are constant causes of trouble; extreme care is reqnired by the operators to avoid receiving the dangerous and often fatal current; the machinery runs at high speed, requiring buildings and foundations of the most substanial construction.

Compressed air has none of these difficulties to contend with. The compressor is but little more than a steam engine with one or more extra cylinders and their valves, all of simple design; it runs at safe speeds, is clean, comparatively noiseless, and safe in every way, and the same may be said of the compressed air machine at the other end of the line, considered in itself.

In addition to other advantages; the expanding air exhausted into the atmosphere is a medium under control for ventilating and cooling, a feature often of importance in engine rooms and particularly so in mining.

Advance in any line always has a certain amount of predjudice to overcome, and compressed air has this to encounter in its progress. Its advocates in no way attempt to underate the importance electricity holds in fields peculiarly adapted to itself, in these it still reigns supreme. Give compressed air a stand on its own merits, with appliances to suit the conditions, and we have a medium of transmission convenient and economical, and susceptible of a wonderful variety of applications.

*Industrial Reporter*

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Mr. J. N. Weaver, Master Mechanic of the Sayre, N. Y. shops of the Lehigh Valley R. R , has lately constructed a device for use on bush work and also to press driving boxes in and out.

The tool was made out of an old 19x24 locomotive cylinder and is mounted on legs at a convenient height to handle work. It is operated by compressed air.

## COMPRESSED AIR.

(CONTINUED.)

AIR COMPRESSING MACHINES.

In describing air pumps or compressors we will endeavor to confine ourselves strictly to such machines as are at the present time in practical operation. The large field of patented designs, antiquated types and such like, will be omitted.

The simplest form of air pump is the little apparatus with which every one is familiar, namely, the pump for inflating the bicycle tire, Fig. 16.

FIG. 16. A BICYCLE AIR PUMP.

This little pump is made both single and double acting, the single acting device being the simplest form of air compressor. The piston rod is the discharge passage, the piston packing being a simple leather washer which is aided by the air pressure in forming a perfectly tight joint, the piston is fixed, the cylinder being grasped in the hand and forced forward. This little device is interesting in that its use reminds us of an important fact in air compressing —the development of heat. After a few strokes the heat produced is quite perceptible. This heat is not due to friction, but it represents the conversion of the work done by the hand into heat. When there is little resistance or little air in the tire the heating is not noticed because but little work is done. As soon, however, as the tire becomes inflated the action of the pump is more difficult to perform and the heat increases. It is not an uncommon experience for this pump to fail to act, due to the sticking of the little check valve which connects the cylinder through the piston rod with the interior of the tire. When this valve is stuck it will be noticed that on pressing the pump cylinder forward and letting go, it is quickly pushed back to its original position, heat has been produced and there is evidently a pressure within the cylinder tending to hold its front end firmly against the piston. Where does this pressure come from? We had only free air and no pressure before giving the stroke to the cylinder and now it has returned to its original position and tends to go further. There has been no leakage from the tire because the check valve is tight and immovable. We have simply compressed a volume of confined air as we would compress a spring, yet unlike a spring it apparently has power to go further than its original position. This is because we have done work upon the air, it has failed to get away, heat has been produced because the air has done no work in return. This heat expands the air, thus giving it additional power to recover, and as the cylinder is a light thing it is pushed back to its original position with but little expenditure of energy. If the pump and its confined air are now allowed to cool down to the temperature of the surrounding atmosphere the tension in the cylinder will be relieved and the original conditions will be recovered. Even a bicycle pump may teach us important lessons in thermodynamics.

Hand pumps of larger sizes are made for medical service and other uses, the principle being simply that of a piston forced backward and forward in a cylinder. Where larger volumes of air are required hand pumps provided with fly-wheels and operated by one or more men have been introduced and are largely used. The commonest pattern is the Vertical Belt or Hand Air Pump (Fig. 17), which may be run by hand or by power as desired.

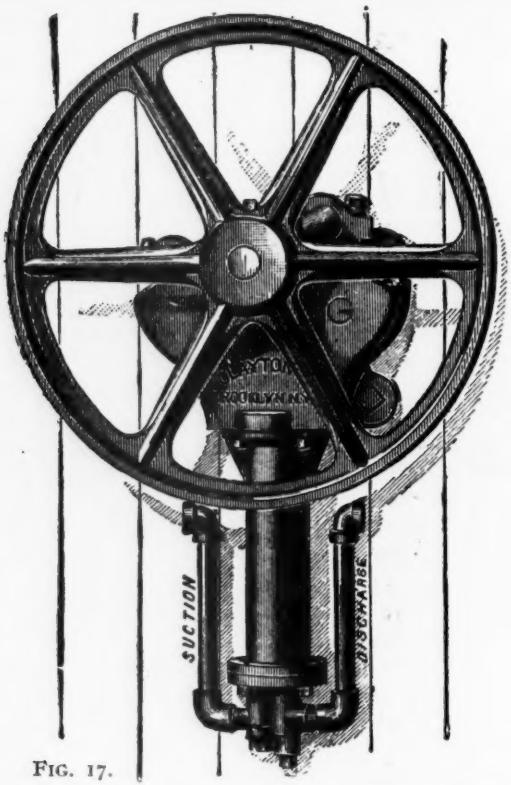


FIG. 17.

VERTICAL, BELT OR HAND AIR PUMPS.
PRICE LIST.

| Number. | Diameter of Air Cylinder in inches. | Length of Stroke in inches. | Number of Revolutions per minute. | Cu. Ft. Measurement of Free Air Compressed per min. | Attainable Air Pressure in lbs. per square inch. | Price. |
|---|---|---|---|---|---|---|
| 1 | 2 | 6 | 150 | 1 | 300 | $50 |
| 2 | 2¼ | 6 | 150 | 2 | 300 | 50 |
| 3 | 3 | 6 | 150 | 3 | 250 | 60 |
| 4 | 4 | 6 | 140 | 6 | 200 | 70 |
| 5 | 5 | 6 | 140 | 10 | 150 | 80 |
| 6 | 6 | 6 | 130 | 13 | 100 | 90 |
| 7 | 7 | 6 | 130 | 17 | 50 | 110 |
| 8 | 8 | 6 | 120 | 20 | 30 | 130 |

The High-Pressure, Vertical, Belt Air Pumps are built in response to many applications for a reliable and small belt or hand power air pump to compress air to 300 pounds pressure. There have been several more or less important improvements made on the original design, and on the larger sizes the suction and discharge pipes are cast solid to the cylinder.

They can be bolted against any pillar, wall or strong board, and driven by a heavy pulley wheel of such diameter and width of face as required to attain the pressure wanted; when required to be worked by hand power they are provided with a handle in fly-wheel, which can be run by one or two men to a proportionate pressure.

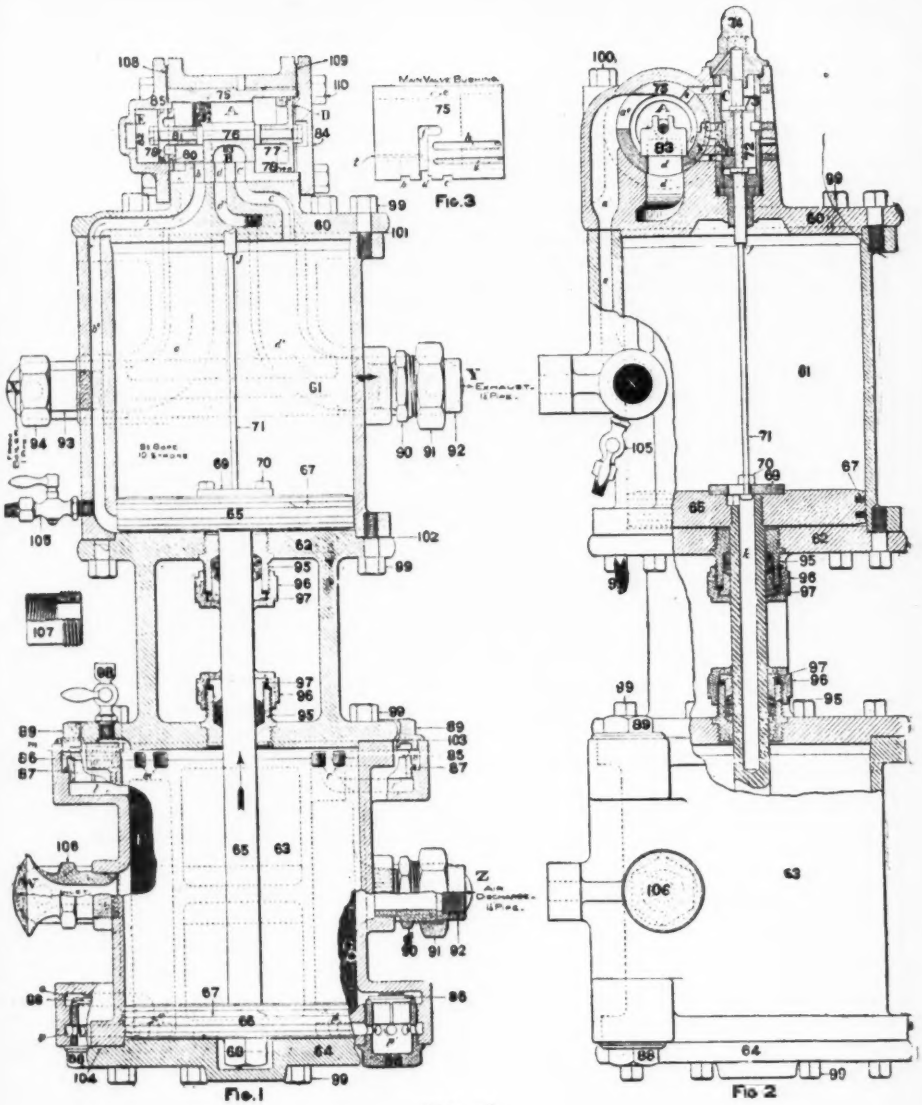


FIG. 18.

The air brake pump is the simplest form of power air compressor with which we are familiar. Furthermore it is a machine so largely used that it deserves more than a passing notice. There are more air compressors used for the purpose of operating brakes than for all other purposes combined. It has been estimated that 30,000 of these pumps are in service. Fig. 18 illustrates the improved 9½ inch Westinghouse pump.

THE NINE AND ONE-HALF INCH IMPROVED AIR PUMP.

DESCRIPTION OF THE AIR BRAKE PUMP.

60. Top Head, complete (Includes parts Nos. 72, 73, 74, 75, 76, 83, 84, 85, 108, 109 and 8, of 110)
61. Steam-cylinder, complete. (Includes parts Nos. 90, 91, 92, 93 and 94.)
62. Centre Piece, complete. (Includes parts Nos. 2 each of 95, 96 and 97.)
63. Air-cylinder, complete. (Includes parts Nos. 4 of 86, 2 each of 87, 88 and 89, and 1 each of 90, 91, 92, and 106.)
64. Lower Head.
65. Steam Piston and Rod. (Includes 2 each of 67 and 68, 69 and 2 of 70.(
66. Air Piston, Complete, (Includes 2 of 67,)
67. Piston Packing Ring.
68. Piston Rod Nut.
69. Reversing-Valve Plate.
70. Reversing-Valve Plate Bolt.
71. Reversing-Valve Rod.
72. Reversing-Valve.
73. Reversing-Valve Chamber Bush.
74. Reversing-Valve Chamber Cap.
75. Main Valve Bush.
76. Main Piston Valve, complete. (Includes Nos. 77, 2 of 78, 79, 2 of 80, 81 and 4 of 82.)
77. Large Main Valve Piston Head. (Includes 2 of No, 78.)
78. Large Main Valve Piston Packing Ring.
79. Small Main Valve Piston Head. (Includes 2 of No. 80.)
80. Small Main Valve Piston Packing Ring.
81. Main Valve Stem.
82. Main Valve Stem Nut.
83. Main Slide Valve.
84. Right Main Valve Cylinder Head.
85. Left Main Valve Cylinder Head.
86. Air Valve.
87. Air Valve Seat.
88. Air Valve Cage.
89. Valve Chamber Cap.
90. One and One-fourth Inch Union Stud.
91. One and One-fourth Inch Union Nut.
92. One and One-fourth Inch Union Swivel.
93. One Inch Steam Pipe Stud.
94. Governor Union Nut.
95. Stuffing Box.
96. Stuffing Box Nut.
97. Stuffing Box Gland.
98. Air-cylinder Oil Cup.
99. Short Cap Screw.
100. Long Cap Screw.
101. Upper Steam Cylinder Gasket.
102. Lower Steam Cylinder Gasket.
103. Upper Air-cylinder Gasket.
104. Lower Air-cylinder Gasket.
105. Drain Cock.
106. Air Strainer.
107. One Inch Steam Pipe Sleeve.
108. Left Main Valve Head Gasket.
109. Right Main Valve Head Gasket.
110. Main Valve Head Bolt.

This air pump was designed without any thought of economy in the use of steam, the main consideration being economy of space, light weight and absolute reliability of action. Economy in the use of steam to compress the air is quite secondary to other and more important considerations. The use of a crank and fly-wheel is incompatible with economy of space, and a compressor with directly operated steam valves is a necessity. Because of this the clearance space in the air cylinder must be about double that required in a fly-wheel machine in order to avoid pounding. The steam ports; and especially the exhaust ports, must be contracted to prevent too high piston speed and consequent pounding when the pump is working against low air pressures. For the same reason the air discharge valves must also be small. The steam must be used non-expansively as the resistance of the air pressure is greatest toward the end of the stroke, requiring the highest steam pressure at that time, and having no inertia of moving parts to help it around the center. W. L. SAUNDERS.

### Transmission Through Pneumatic Tubes.

The writer having been employed in designing the extension of a pneumatic dispatch line, in which some heavy gradients were unavoidable, it became necessary to ascertain by calculation the steepest gradient that could be employed so as to obtain a sufficient carrying capacity in the new section of the line under given conditions of engine power and of length. Almost every text-book and paper on the velocity of gases in pipes, gave a different formula, and the author therefore found it necessary to attempt to construct a convenient expression for the speeds of carriers of given weight and friction, under various conditions of pressure, gradients, and dimensions of tube. The problem of a pneumatic system is simply this: To make a given quantity of air expand from one pressure to another in such a way as to return a fair equivalent of the work expended in compressing it. It is obviously impossible to regain the full equivalent of the work, because the compression is attended with the liberation of heat, which is dissipated and practically lost. Therefore, in designing a pneumatic system, the first thing is to contrive means of compressing the air as economically as possible; and, in the second place, to get back the available mechanical effort stored up in the compressed air; irrespectively of the work employed in compressing and examining it. The writer considers that small pneumatic tubes may be worked more profitably than large ones. The great convenience of and the practical facilities for working small letter-carrying tubes have been amply proved by the extensive systems already laid down in Paris, Berlin, London, and other towns, as adjuncts to the telegraph services. Tubes of somewhat larger diameter would undoubtedly work satisfactorily. Even still larger tubes, of a moderate length, might also be found useful for a variety of special applications But the author does not believe that a pneumatic line working through a long tunnel could, for passenger traffic, ever compete in point of economy, with locomotive railways. A pneumatic railway is essentially a rope railway. Its rope is elastic, it is true, but it is not light. Every yard run of it, in a tunnel large enough to carry passengers, would weigh more than ¼ cwt. And it is rope, too, which has to be moved against considerable friction, and in being compressed and moved wastes power by its liberation of heat. In a pneumatic tunnel, such as that proposed between England and France, in order to move a goods train of 250 tons through at the rate of 25 miles an hour, it would be necessary to employ simultaneously a pressure of 1½ lbs. per sq. in. at one end, and a vacuum of 1½ lbs per sq. in. at the other. The mechanical effect obtained of these combined—pressure and vacuum—would be consumed as follows:

| | | |
|---|---|---|
| In accelerating the air . . | 29 | millions of foot pounds |
| In accelerating the train . | 12 | |
| By friction of the air . . | 5721 | |
| By friction of the train . . | 330 | |

The resistance of the air, therefore, upon the walls of the tunnel would alone amount to 93 per cent. of the total mechanical effect employable for the transmission; while the really useful work would be only about 5½ per cent. of it. And to compress and exhaust the air to supply these items of expenditure of mechanical effect, engines would have to exert over 2,000-horse power at each end during the transmission, even on the supposition that the blowing machinery returned an equivalent of mechanical effect such as has never yet been obtained. This would not be an economical way of burning coals.

*Journal of the Telegraph.*

## COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSD AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

EDITOR, COMPRESSED AIR:

Will you answer through the columns of your valuable paper the following questions to settle a point at issue.

How much less power will it take to compress a certain volume of free air to say, 500 lbs receiver pressure, by using a three cylinder recompressor, each cylinder decreasing in a four-fold proportion, than a one cylinder compressor, to put the same amount of free air into the receiver against the same pressure or 500 lbs.

J. S. SHERMAN.

To compress 1 cu. ft. of free air in one cylinder to 500 lbs. gauge pressure, will require an expenditure of 173,000 foot-pounds of energy, provided no account is taken of jacket cooling—and to compress the same quantity of free air per minute in three cylinders to 500 lbs. terminal pressure (the ratio of cylinder areas being 3.4) will require an expenditure of 127,000 foot-pounds of energy, provided no account is taken of jacket cooling, but all heat of compression is to be abstracted by intercoolers between the first and second and third cylinders.

### Wants.

A correspondent wishes to know where he can obtain information in regard to operating and constructing a compressed air whitewashing machine.

If the makers of these machines will communicate with this journal we will be glad to forward the information to our inquirer.

The Master Mechanic of the Lehigh Valley shops at East Buffalo, N. Y., Mr. John Campbell; has solved an annoying difficulty which attended the storage of cotton waste and other material which is kept on the upper floor of the oil house. He has taken an eight inch Westinghouse air pump with the pump left off. Only the steam end and its reversing mechanism is used, and compressed air is taken for the power instead of steam. It is a novelty in air machines and is capable of lifting 2,000 pounds.

### Books.

"Roentgen Rays and Phenoma of the Anode and Cathode," is the title of a new publication we have from D. Van Nostrand & Co., New York. In it the author, Edward P. Thompson, M. E., E. E., discusses and illustrates the principles, applications, and theories of this wonderful discovery. The book will be useful to scientists, electricians and others interested in such experiments as may be made in developing this new science.

There are sixty diagrams and forty-five half-tone views of apparatus and reproductions of X Ray effects, that are very interesting and instructive. A large number of views from sciagraphs of various objects are shown. Coins, keys, rings, fountain pens, as seen through a leather purse. Also a varied exhibit of bones and other interiors.

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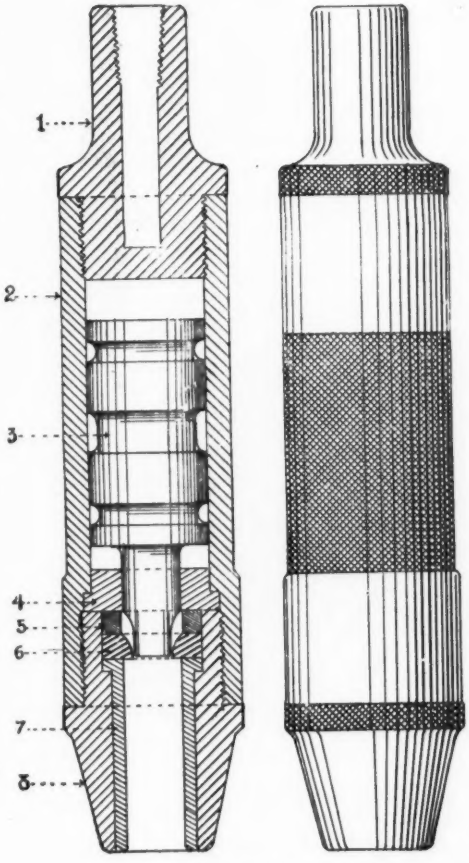


*Parts*

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2. *Cylinder*
3. *Hammer*
4. *Hammer Washer*
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6. *Tool Washer*
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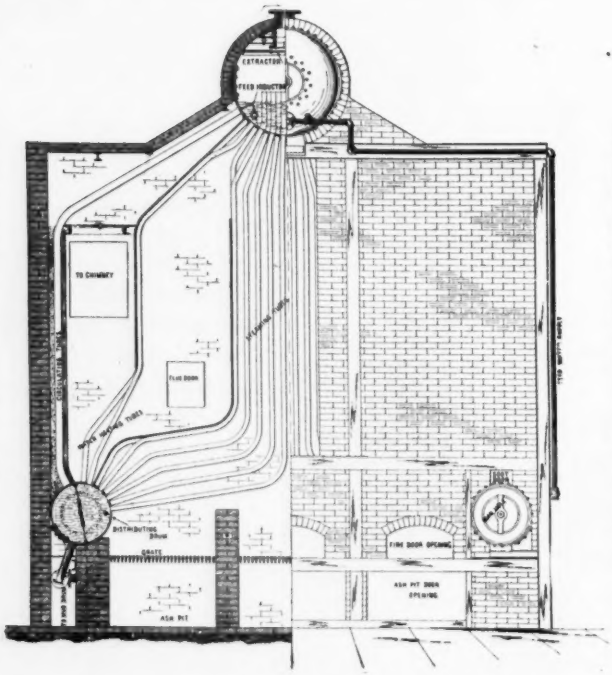


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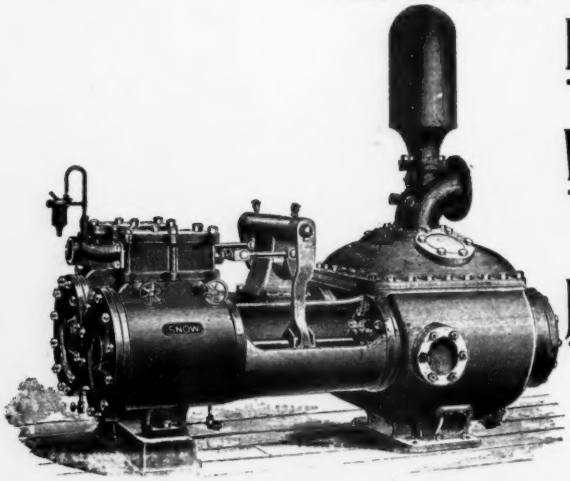


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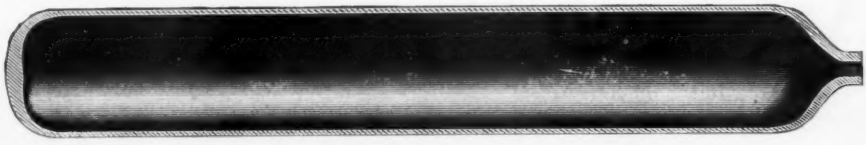

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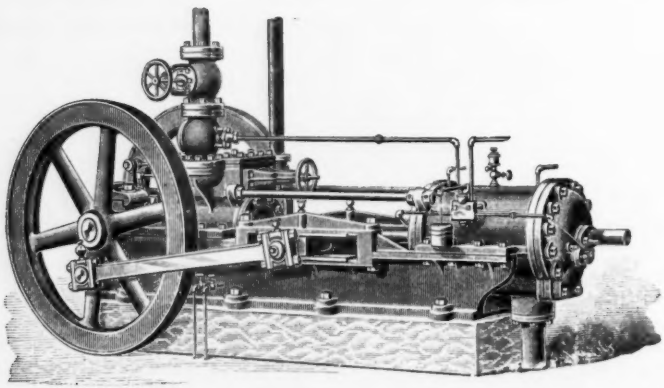

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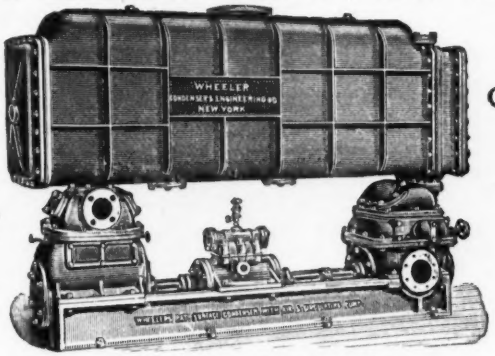


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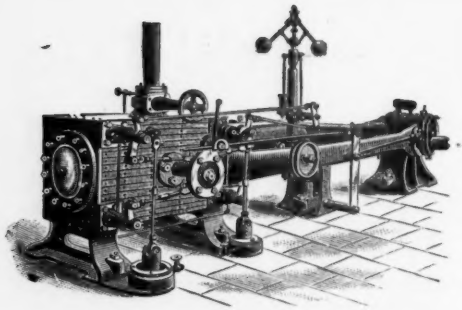

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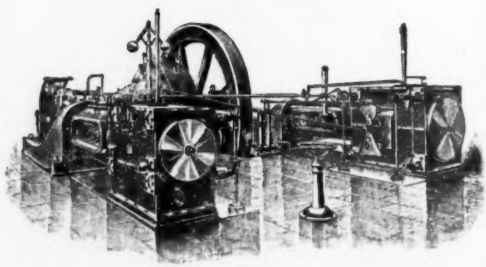

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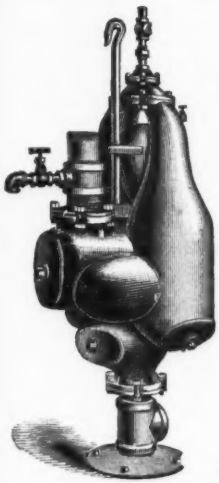

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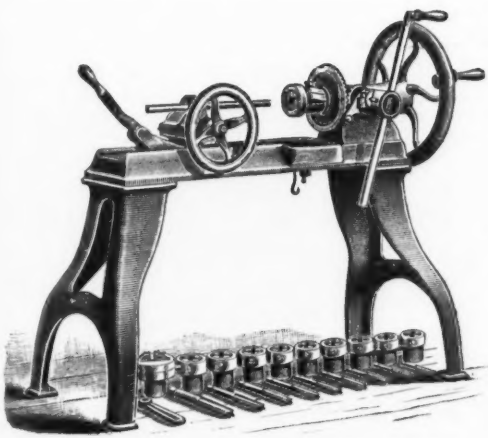

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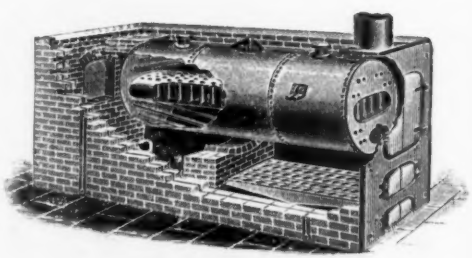

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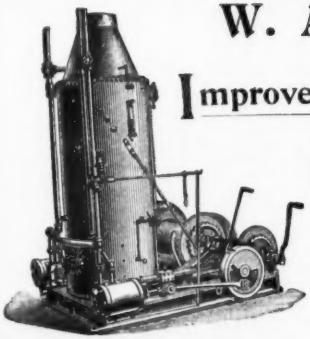

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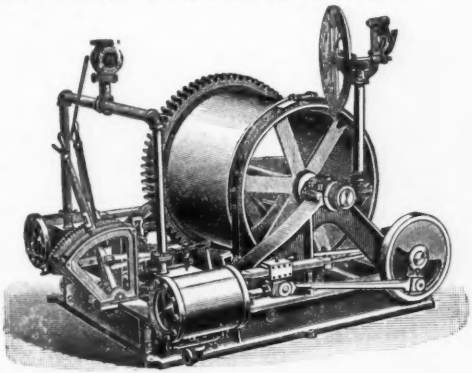

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FRANKLAND JANNUS,
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Always have Title Examined before Investing in Patent Property.

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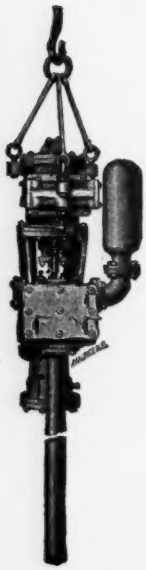

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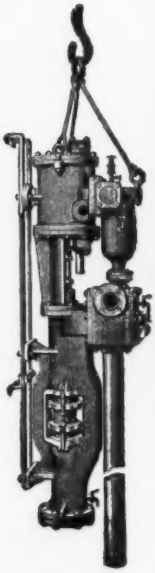

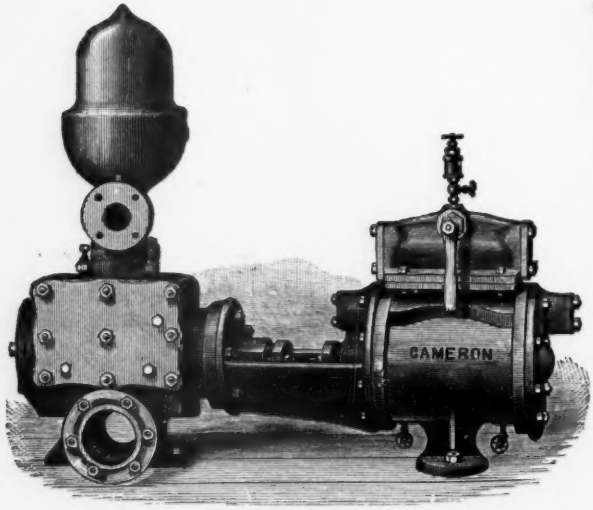


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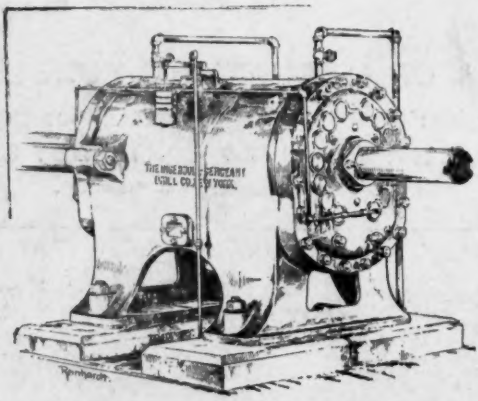

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